

On recent discovery of new planetoids in the solar system and quantization of celestial system

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The present note revised the preceding article discussing new discovery of a new planetoid in the solar system. Some recent discoveries have been included, and its implications in the context of quantization of celestial system are discussed, in particular from the viewpoint of superfluid dynamics. In effect, it seems that there are reasons to argue in favor of gravitation-related phenomena from boson condensation.

Keywords: quantization, planetary orbit, quantized superfluid, boson condensation, gravitation

Discovery of new planetoids

Discovery of new objects in the solar system is always interesting for astronomers and astrophysicists alike, not only because such discovery is very rare, but because it also presents new observation data which enables astronomers to verify what has been known concerning how our solar system is functioning.

In recent years a number of new planetoids have been reported, in particular by M. Brown and his team [1][2][3][4]. While new planet discoveries have been reported from time to time, known as *exoplanets* [9][10], nonetheless discovery of new planetoids in the solar system are very interesting, because they are found after a long period of silence after Pluto finding, around seventy years ago. Therefore, it seems interesting to find out implications of this discovery to our knowledge of solar system, in particular in the context of quantization of celestial system.

As we discussed in the preceding article [5], there are some known methods in the literature to predict planetary orbits using quantumwave-like approach, instead of classical dynamics approach. These new approaches have similarity, i.e. they extend the Bohr-Sommerfeld's quantization of angular momentum to large-scale celestial systems. This application of wave mechanics to large-scale structures [6] has led to several impressive results in particular to predict orbits of exoplanets [8][9][10]. However, in the present note we will not discuss again the physical meaning of wave mechanics of such large-scale structures, but instead to focus on discovery of new planetoids in solar system in the context of quantization of celestial system.

As contrary as it may seem to present belief that it is unlikely to find new planets beyond Pluto, Brown *et al.* have reported not less than four new planetoids in the outer side of Pluto orbit, including 2003EL61 (at 52AU), 2005FY9 (at 52AU), 2003VB12 (at 76AU, dubbed as *Sedna*). It is somewhat different to our preceding article suggesting orbit distance = 86AU in accordance with ref. [14]). And recently Brown and his team report new planetoid finding, dubbed as 2003UB31 (97AU). This is not to include *Quaoar* (42AU), which has orbit distance more or less near Pluto (39.5AU), therefore this object is excluded from our discussion. Before discovery of 2003UB31

(Brown himself prefers to call it '*Lila*'), Sedna has been reported as the most distant object found in the solar system, but its mass is less than Pluto, therefore one could argue whether it could be considered as a 'new planet'. But 2003UB31 is reported to have mass definitely greater than Pluto, therefore Brown argues that it is definitely worth to be considered as a 'new planet'. (Table 1)

Table 1. Comparison of prediction and observed orbit distance of planets in the Solar system (in 0.1AU unit)

Object	No.	Titius	Nottale	CSV	Observed	Δ (%)
	1		0.4	0.428		
	2		1.7	1.71		
Mercury	3	4	3.9	3.85	3.87	0.52
Venus	4	7	6.8	6.84	7.32	6.50
Earth	5	10	10.7	10.70	10.00	-6.95
Mars	6	16	15.4	15.4	15.24	-1.05
Hungarias	7		21.0	20.96	20.99	0.14
Asteroid	8		27.4	27.38	27.0	1.40
Camilla	9		34.7	34.6	31.5	-10.00
Jupiter	2	52		45.52	52.03	12.51
Saturn	3	100		102.4	95.39	-7.38
Uranus	4	196		182.1	191.9	5.11
Neptune	5			284.5	301	5.48
Pluto	6	388		409.7	395	-3.72
2003EL61	7			557.7	520	-7.24
Sedna	8	722		728.4	760	4.16
2003UB31	9			921.8	970	4.96
Unobserved	10			1138.1		
Unobserved	11			1377.1		

Moreover, from the viewpoint of quantization of celestial systems, these findings provide us with a set of unique data to be compared with our prediction based on CSV hypothesis [5]. It is therefore interesting to remark here that all of those new ‘planetoids’ are within 8% bound compared to our prediction (Table 1). While this result does not yield high-precision accuracy, one could argue that this 8% bound limit corresponds to the remaining planets, including inner planets. Therefore this 8% uncertainty could be attributed to macroquantum uncertainty and other local factors.

What’s more interesting here is perhaps that some authors have argued using gravitational Schrödinger equation [12], that it is *unlikely to find new planets beyond Pluto* because density distribution becomes near zero according to the solution of Schrödinger equation [7][8][11]. From this viewpoint, one could argue concerning to how extent applicability of gravitational Schrödinger equation to predict quantization of celestial systems, despite its remarkable usefulness to predict exoplanets [9][10].

Therefore in the subsequent section, we argue that using Ginzburg-Landau equation, which is more consistent with superfluid dynamics, one could derive similar result with known gravitational Bohr-Sommerfeld quantization [13][15]:

$$a_n = GMn^2 / v_o^2 \quad (1)$$

where a_n , G , M , n , v_o each represents orbit radius for given n , Newton gravitation constant, mass of the Sun, quantum number, and specific velocity ($v_o=144$ km/sec for Solar system and also exoplanet systems), respectively [7][8].

Interpretation

In principle the Cantorian superfluid vortex (CSV) hypothesis [5] suggests that the quantization of celestial systems corresponds to superfluid quantized vortices, where it is known that such vortices are subject to quantization condition of integer multiples of 2π , or $\oint \mathbf{v}_s \cdot d\mathbf{l} = 2\mathbf{p} \cdot \mathbf{n} \hbar / m_4$ [5]. For a *planar cylindrical case* of solar system, this hypothesis leads to Bohr-Sommerfeld-type quantization of planetary orbits. It is also worthnoting here, while likelihood to find planetoid at around 90AU has been predicted by some astronomers, our prediction of new planets corresponding to $n=7$ (55.8AU) and $n=8$ (72.8AU) were purely derived from Bohr-Sommerfeld quantization [5].

The CSV hypothesis starts with observation that in quantum fluid systems like superfluidity, quantized vortices are distributed in equal distance, which phenomenon is known as vorticity. In a large superfluid system, we usually use Landau two-fluid model, with normal and superfluid component. Therefore, in the present note we will not discuss again celestial quantization using Bohr-Sommerfeld quantization, but instead will derive equation (1) from Ginzburg-Landau equation, which is known to be more consistent with superfluid dynamics. To our knowledge, deriving equation (1) from Ginzburg-Landau equation has *never* been made before elsewhere.

According to Gross, Pitaevskii, Ginzburg, wavefunction of N bosons of a reduced mass m^* can be described as [17]:

$$-(\hbar^2 / 2m^*) \cdot \nabla^2 \mathbf{y} + \mathbf{k}|\mathbf{y}|^2 \mathbf{y} = i\hbar \partial \mathbf{y} / \partial t \quad (2)$$

For some conditions, it is possible to substitute the potential energy term ($\mathbf{k}|\mathbf{y}|^2$) in (2) by Hulthen potential, which yields:

$$-(\hbar^2 / 2m^*) \cdot \nabla^2 \mathbf{y} + V_{Hulthen} \mathbf{y} = i\hbar \partial \mathbf{y} / \partial t \quad (3)$$

where Hulthen potential could be written in the form:

$$V_{Hulthen} = -Ze^2 \cdot \mathbf{d} \cdot e^{-\mathbf{d}r} / (1 - e^{-\mathbf{d}r}) \quad (4)$$

It could be shown that for small values of screening parameter \mathbf{d} , the Hulthen potential (4) approximates the effective Coulomb potential:

$$V_{Coulomb}^{eff} = -e^2 / r + \ell(\ell + 1) \cdot \hbar^2 / (2mr^2) \quad (5)$$

Therefore equation (3) could be rewritten as:

$$-\hbar^2 \nabla^2 \mathbf{y} / 2m^* + \left[-e^2 / r + \ell(\ell + 1) \cdot \hbar^2 / (2mr^2) \right] \mathbf{y} = i\hbar \cdot \partial \mathbf{y} / \partial t \quad (6)$$

Interestingly, this equation takes the form of time-dependent Schrödinger equation. In the limit of time-independent case, equation (6) becomes similar with Nottale's time-independent gravitational Schrödinger equation from Scale relativistic hypothesis with Kepler potential [7][8][9]:

$$2D^2 \Delta \Psi + (E / m + GM / r) \cdot \Psi = 0 \quad (7)$$

Solving this equation with Hulthen effect (4) will make difference, but for gravitational case it will yield different result only at the order of 10^{-39} m compared to prediction using equation (7), which is of course negligible. Therefore, we conclude that for most celestial quantization problems the result of TDGL-Hulthen (3) is *essentially* the same with the result derived from equation (7).

Furthermore, the extra potential to Keplerian potential in equation (5) is also negligible, in accordance with Pitkanen's remarks: "centrifugal potential $l(l + 1) / r^2$ in the Schrödinger equation is negligible as compared to the potential term at large distances so that one expects that degeneracies of orbits with small values of l do not depend on the radius." [18]

It seems also worth noting here that planetoids 2003EL61 and 2005FY9 correspond to orbit distance of 52AU. This pair of planetoids could also be associated with Pluto-Charon pair. In the context of macroquantum phenomena of condensed matter physics,

one could argue whether these pairs indeed correspond to macroobject counterpart of Cooper pairs [16]. While this conjecture remains open for discussion, we predict that more paired-objects similar to these planetoids will be found beyond Kuiper belt. This will be interesting for future observation.

Furthermore, while our previous prediction only limits new planetoids finding until $n=9$ of Jovian planets (outer solar system), it seems that there are more than sufficient reasons to expect that more planetoids are to be found in the near future. Therefore it is recommended to extend further the same quantization method to larger n values. For prediction purpose, we have included in Table 1 new expected orbits based on the same celestial quantization as described above. For Jovian planets corresponding to $n=10$ and $n=11$, our prediction yields likelihood to find orbits around 113.81 AU and 137.71 AU, respectively. It is recommended therefore, to find new objects around these predicted orbits.

In this note, we revised our preceding article suggesting that Sedna corresponds to orbit distance 86AU, and included recently found planetoids in the outer solar system as reported by Brown *et al.* While our previous prediction only limits new planet finding until $n=9$ corresponding to outer solar system, it seems that there are reasons to expect that more planetoids are to be found. While in the present note, we argue in favor of superfluid-quantized vortices, it does not mean to be the only plausible approach. Instead, we consider this discovery as a new milestone to lead us to find better cosmological theories, in particular taking into consideration some recent remarkable observation of exoplanets as predicted by wave mechanics approach.

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